AMENDMENTS TO THE CLAIMS

Please amend claims 1, 2, 4, 5-8, and 13-24.

1. (Currently amended) A method for channel estimation for an optical receiver comprising the steps of:

the optical receiver digitizing an analog signal ($\tilde{r}(t)$) representing a sequence of symbols (d_i) thereby associating [[one]] a digital word [[($r_{i,1}$, $r_{i,2}$)]] out of a plurality of possible digital words to the level of said analog signal at each sampling time; a symbol period having at least two sampling times; each digital word corresponding to one out of a plurality of quantization levels;

determining the most likely sequence (u_1) of said symbols(d_1);

providing [[a]] branch metrics; and

obtaining said branch metrics from frequencies of the digital words [[($r_{i,1}$, $r_{i,2}$)]]resulting from said digitizing and the symbols of said most likely sequence (u_1).

2. (Currently amended) A method for channel estimation comprising the steps of:

digitizing an analog signal ($\tilde{r}(t)$) having a sequence of symbols (d_1) thereby associating one digital word ($r_{i,1}$, $r_{i,2}$) out of a plurality of digital words to the level of said analog signal at each sampling time; a symbol period having at least one sampling time; each digital word corresponding to one out of a plurality of quantization levels;

determining the most likely sequence (u_1) of said symbols (d_i);

counting at least one event; thereby obtaining a counter value for each event; each event being defined by a channel state and a current digital word; each channel state being defined by a pattern of symbols relative to a current symbol determined at the time of said current digital word;

fitting a model distribution to said counter values; and

obtaining a branch metric on the basis of said fitted model distribution.

3. (Original) The method of claim 2, wherein the symbol period comprises at least two sampling times.

4. (Currently amended) The method of claim 1, further comprising the steps of:

counting each kind of [[an]] event during said digitizing to produce a count, each event being defined by a channel state and a digital word out of said plurality of digital words; each channel state being defined by a sequence of symbols;

calculating a sample branch metric for each kind of [[an]] event; and

calculating a branch metric by combining the sample branch metric[[s]] for each digital word obtained at a sampling time during a symbol period.

5. (Currently amended) The method of claim 1, wherein each symbol period includes a first sampling time and a second sampling time and further comprising the steps of:

associating a first digital word [[$(r_{1,1})$]] at the first sampling time and a second digital word [[$(r_{1,2})$]] at the second sampling time to said analog signal;

counting one or more of a first ~~kind of~~ event, each said first ~~kind of~~ event being defined by a first channel state and [[a]] the first digital word; each first channel state being defined by a sequence of symbols comprising the symbol to which said first digital word is associated;

counting [[a]] one or more of a second ~~kind of~~ event, each of said second ~~kind of~~ event being defined by said first channel state, said first digital word and second digital word following said first digital word;

calculating a first sample branch metric for each said first ~~kind of~~ event;

calculating a second sample branch metric for each said second ~~kind of~~ event; and

calculating a branch metric for a second channel state and [[a]] third and fourth digital words by combining the first sample branch metric for said second channel state and said third digital word and a second sample branch metric for said second channel state, said third digital word and said fourth digital word; said second channel state being defined by [[a]] the sequence of symbols comprising a symbol to which said third and fourth digital words are associated.

6. (Currently amended) The method of claim 1, wherein each symbol period includes a first sampling time and a second sampling time, and further comprising the steps of:

associating a first digital word [[($r_{i,1,}$)]] at the first sampling time and a second digital [[($r_{1,2,}$)]] word at the second sampling time to said analog signal;

counting a first kind of event, each first kind of event being defined by a first channel state and [[a]] the first digital word; each first channel state being defined by [[a]] the sequence of symbols comprising the symbol to which said first digital word is associated;

grouping said possible digital words into groups of digital words; associating a coarse digital word to each group of digital words;

counting a second kind of event, each second kind of event being defined by said first channel state, the coarse digital word associated to said first digital word and the second digital word following said first digital word;

calculating a first sample branch metric for each said first kind of event;

calculating a second sample branch metric for each said second kind of event; and

calculating a branch metric for a second channel state and [[a]] third and fourth digital words, by combining the first sample branch metric for said

second channel state and said third digital word and [[a]] the second sample branch metric for said second channel state, a coarse digital word associated with said third digital word and said fourth digital word; said second channel state being defined by [[a]] the sequence of symbols comprising the symbol to which said third and fourth digital words are associated.

7. (Currently amended) The method of claim 1, wherein each symbol period includes a plurality of sampling times and further comprising the steps of:

counting at least one kind of event, each kind of event being defined by a first channel state, and a digital word [[($r_{i,1}$, $r_{i,2}$)]] for each sampling time during a symbol period of a first symbol;

each first channel state being defined by [[a]] the sequence of symbols comprising the first symbol;

calculating a sample branch metric for each kind of event; and

calculating a branch metric for a second channel state and a second symbol by combining the sample branch metrics for said second channel state and each digital word associated to said second symbol; said second channel state being defined by [[a]] the sequence of symbols comprising the second symbol.

8. (Currently amended) The method of claim 4, wherein said sample branch metric is a logarithm of the count of the respective kind of event and the ~~combining~~ combination of sample branch metrics is performed by adding the count.

9. (Original) The method of claim 4, further comprising the steps of:

fitting a model distribution to the counts of each kind of event;

evaluating the model distribution for each kind of event in order to obtain one model value for each kind of event; and

calculating said sample branch metric for each kind of event using the respective model value.

10. (Original) The method of claim 1, further comprising the steps of:

recovering the clock of the symbols; and

delaying said clock in order to minimize a bit error rate of said digitized analog signal by optimizing the sampling times during said digitizing.

11. (Original) The method of claim 10, wherein the delay of said clock is adjusted based on bit error rate estimates obtained from said most likely sequence (u_1) of symbols (d_i).

12. (Original) The method of claim 11, wherein the delay of said clock is adjusted in order to maximize a population difference parameter.

13. (Currently amended) The method of claim 1, further comprising the steps of:

adjusting the sampling times by delaying [[said]] a clock by a delay being quasi-continuously adjustable within a range of half of [[a]] the symbol period; and

performing discrete sampling time adjustment by rearranging the sequence of digital words.

14. (Currently amended) The method of claim 2, further comprising the steps of:

counting each kind of event[[s]] during a current accumulation period (k[[+1]]), said channel state being determined on branch metrics being calculated during a previous accumulation period (k-1); and

calculating the branch metrics for determining the channel states during a following accumulation period (k+1[[2]]) while each kind of event[[s]] is counted during the current accumulation period (k[[+1]]).

15. (Currently amended) The method of claim 1, wherein the branch metrics are calculated for determining [[the]] a channel state[[s]] during a following accumulation period (k+1[[2]]) as the sum of the branch metrics for determining the channel state during [[the]] a current accumulation period (k[[+1]]) weighted by a forgetting factor plus the logarithm of [[the]] a respective count of events obtained during [[the]] a previous accumulation period (k-1) weighted by one minus the forgetting factor.

16. (Currently amended) The method of claim 2, wherein the branch metrics are calculated for determining the channel states during a following accumulation period (k+1[[2]]) as the logarithm of the sum of the count of events obtained during accumulation periods before [[the]] a previous accumulation period (k-1) weighted by a forgetting factor plus the count of events obtained during the previous accumulation period (k-1) weighted by one minus the forgetting factor.

17. (Currently amended) The method of claim 1, further comprising the steps of:

defining a channel state as a sequence of binary symbols which represent [[may be represented by]] "0" or "1"; and

setting the branch metrics for the channel states for isolated 0s and 1s "i.e."...11011..." and "...00100...", respectively, to identical values when initializing the branch metrics.

18. (Currently amended) The method of claim 1, further comprising the steps of:

defining a channel state as a sequence of binary symbols which represent [[may be represented by]] "0" or "1"; and

setting the branch metrics of channel states symmetrical to a considered symbol b_3 i.e. $b_1b_2b_3b_4b_5$ and $b_5b_4b_3b_2b_1$ to identical values when initializing the branch metrics.

19. (Currently amended) The method of claim 18, further comprising the steps of:

monitoring at least one of the following conditions:

a loss of signal output by [[the]] a physical interface is being cleared;

a bit error rate in said most likely sequence (u1) of symbols is still above a predetermined threshold after a predetermined period of time after the initialization of said branch metrics;

pathological amplitude statistics are determined comprising one of [[the following cases]]:

a correlation between a only-1 channel state and an only-0 channel state being above a predetermined threshold;

a mode of only-1 channel state below;

a predetermined threshold;

a mode of only-0 channel state above predetermined threshold; and a correlation of histograms with uniform distribution above a given threshold; and

initializing said branch metrics if one of the conditions above occurs.

20. (Currently amended) The method of claim 19, wherein the branch metrics are reinitialized with different values than [[the]] values used at the previous initialization.

21. (Currently amended) The method of claim 2, wherein each symbol period includes a first sampling time and a second sampling time and further comprising the steps of:

associating a first digital word [[($r_{i,1,}$)]] at the first sampling time and a second digital word [[($r_{1,21}$)]] at the second sampling time to said analog signal;

counting one or more of a first ~~kind of~~ event, each said first ~~kind of~~ event being defined by a first channel state and [[a]] the first digital word; each first channel state being defined by [[a]] the sequence of symbols comprising the symbol to which said first digital word is associated;

counting one or more of a second ~~kind of~~ event, each said second ~~kind of~~ event being defined by said first channel state, said first digital word and the second digital word, the second digital word following said first digital word;

calculating a first sample branch metric for each said first ~~kind of~~ event;

calculating a second sample branch metric for each said second ~~kind of~~ event; and

calculating [[a]] the branch metric for a second channel state and [[a]] third and fourth digital words by combining the first sample branch metric for said second channel state and the third digital word and [[a]] the second sample branch metric for said second channel state, said third digital word and said fourth digital word; said second channel state being defined by [[a]] the sequence of symbols comprising a symbol to which said third and fourth digital words are associated.

22. (Currently amended) The method of claim 2, wherein the branch metric[[s]] [[are]] is calculated for determining the channel states during a following accumulation period (k+1[[2]]) as [[the]] a sum of the branch metrics for determining the channel state during [[the]] a current accumulation period (k[[+1]]) weighted by a forgetting factor plus the logarithm of the respective

count of events obtained during [[the]] a previous accumulation period (k-1) weighted by one minus the forgetting factor.

23. (Currently amended) The method of claim 2, further comprising the steps of:

defining [[a]] the channel state as a sequence of binary symbols which represent [[may be represented by]] "0" or "1"; and

setting the branch metric[[s]] for the channel state[[s]] for isolated 0s and 1s "i.e."...11011..." and "..00100...", respectively, to identical values when initializing the branch metric[[s]].

24. (Currently amended) A symbol detector for an optical receiver comprising:

an analog-to-digital converter for digitizing an analog signal ($\tilde{r}(t)$) the analog signal including a sequence of symbols (d_i) thereby associating one digital word [[($r_{1,1}, r_{1,2}$)]] out of a plurality of digital words to the level of said analog signal at each sampling time; each symbol period comprising at least two sampling times; each digital word corresponding to one out of a plurality of quantization levels;

a fractionally spaced maximum-likelihood sequence detector operatively coupled to said analog-to-digital converter for determining the most likely sequence (u_1) of said symbols (d_i); and

a channel model unit operatively coupled to said maximum-likelihood sequence detector in order to provide branch metrics to said maximum-likelihood sequence detector, said branch metrics being obtained from frequencies of the digital words [[($r_{1,1}, r_{1,2}$)]] output by said analog-to-digital converter and the symbols (u_i) being determined by said fractionally spaced maximum-likelihood sequence detector.

25. (Original) A symbol detector for an optical receiver comprising:

an analog-to-digital converter for digitizing an analog signal ($\tilde{r}(t)$) including a sequence of symbols (d_i) thereby associating one digital word [[($r_{1,1}, r_{1,2}$)]] out of a plurality of digital words to the level of said analog signal at each sampling time; each symbol period comprising at least one sampling time; each digital word corresponding to one out of a plurality of quantization levels;

a maximum-likelihood sequence detector operatively coupled to said analog-to-digital converter for determining the most likely sequence (u_i) of said symbols (d_i); and

a channel model unit operatively coupled to said maximum-likelihood sequence detector for providing branch metrics to said maximum-likelihood sequence detector and for counting events; each event being defined by a channel state and a current digital word; each channel state being defined by a pattern of symbols relative to a current symbol determined at the time of said current digital word; a counter value being associated to each event, said channel model unit fitting a model distribution to said counter values and obtaining a branch metric based on said fitted model distribution.

26. (Original) The symbol detector of claim 24, wherein said analog-to-digital converter performs two-fold over-sampling.

27. (Original) The symbol detector of claim 24, further comprising a clock recovery subsystem operatively coupled to an input of said analog-to-digital converter for receiving said analog signal ($\tilde{r}(t)$); said clock recovery subsystem for recovering the clock of the symbols; and

a sampling phase adjustment circuit connected to said clock recovery subsystem for delaying said clock in order to minimize the bit error rate of said symbol detector by optimizing the sampling times of said analog-to-digital converter; said clock recovery subsystem being connected to said analog-to-digital converter for providing said delayed clock to said analog-to-digital converter.